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EXTERNAL MEMORANDUM

TO: Bonnie Lavelle

FROM: Mike Ruby, Yvette Lowney, and Joyce Tsuji

CC: Linda Larson, Bob Litle, Dave Folkes

DATE: May 3, 2001

CONTRACT: 8601184.001 0101 0401 0363

SUBJECT: Comments on report titled, "Relative Bioavailability of Lead in Soils from the VBI70 Site"

We have had the opportunity to review the March 2000 report titled, "Relative Bioavailability of Lead in Soils from the VBI70 Site." Based on this review, we have the following comments on the report.

1. <u>Lead mineralogy is inconsistent with high relative bioavailability</u>. The lead mineralogy (as a function of lead mass; Figure 2-2 of the bioavailability report) of both the samples tested *in vivo* was dominated by lead phosphate. The sample characterization section of the report does not discuss the chemistry of these lead phosphate particles, and this information would be useful because the *in vivo* results do not appear to be consistent with this lead mineralogy. In our experience, lead phosphates have not yielded relative bioavailability adjustments (RBAs) as high as those reported in this study. The attached figure summarizes the RBA values for all of the soil samples that have been dosed previously to the swine model by EPA Region VIII (data excerpted from Ruby 1999). The only samples that produced RBA values in the 80 to 90 percent range (similar to the RBAs for the VB I-70 samples) were from the Leadville and Jasper sites and the lead paint sample. These samples were dominated by lead carbonate (cerrusite) and lead oxide (phases that are known to yield high RBA values). In contrast, soils dominated by lead sulfide and lead sulfate—lead phases that are present in the VB I-70 samples to a limited extent—have generally produced relatively low lead bioavailability values.

   We are unsure whether any soils dominated by lead phosphates have been dosed to the swine previously, but we believe that an evaluation of this issue would be worthwhile. Also, it has been demonstrated in several *in vivo* studies that smaller lead particles (for a particular form of lead) will yield greater lead bioavailability values (Barltrop and Meek 1979). However, the particle sizes of the lead phosphate grains in the VB I-70 samples are not particularly small, relative to the lead particle sizes in the other samples previously dosed to the swine (Weston 1995), which suggests that small lead particle size is not the reason for the elevated RBA values observed in the VB I-70 swine study.

Therefore, we recommend that the EPA re-visit the chemistry of these lead phosphate particles, to determine whether these RBA values are supported by the mineralogy, from a mechanistic perspective.

Finally, it should be noted that addition of phosphate amendments to soils, for the specific purpose of reducing lead bioavailability (due to the formation of lead phosphate precipitates, which are generally considered to produce low lead bioavailability values) is being evaluated at a number of NPL sites. (This is occurring at the Joplin, Missouri site [Mark Doolan is the EPA Region VII RPM], and the Coeur d'Alene River Basin [Anne Dailey is the EPA Region X project manager]) . At the Joplin site, phosphate amendments have been demonstrated to reduce relative lead bioavailability in soils (these soils had an initial lead mineralogy dominated by lead carbonate), in both the EPA Region VIII young swine model and in adult humans (see the attached presentations made by Drs. Stan Casteel and Mark Maddaloni at the Society of Toxicology meeting held last month in San Francisco). These results further support the position that the lead mineralogy data are inconsistent with the VB I-70 swine study results.

2) Lead at the VB I-70 Site may be from conventional urban sources. The occurrence of lead in soils is quite common, especially in urban environments, where a number of historical sources of soil contamination exist. These sources can include lead from paint in older homes, and/or contributions from historical use of leaded gasoline. In the downtown Denver area, mean background soil lead concentrations fall in the range of 450–550 ppm, and the range of concentrations can extend much higher (data from Skyline Labs, 1986, as interpreted by EnviroGroup). Due to the location of the site along the I-70 corridor, soils in this area are likely to reflect contributions from the historical use of gasoline. Also, the older housing stock in the study area indicates that the soil lead concentrations will reflect contributions from leaded paint, as is demonstrated in the lead mineralogy analysis. EnviroGroup (1998) found that the median lead concentration in soils around houses over 20 year old is 960 ppm, while the mean concentration for houses in poor condition is 1,140 ppm (Francek 1992). These lead levels in soil are similar to the higher end of the range measured at the VB I-70 site. Therefore, given the age and location of the community, and the soil lead levels, paint and gasoline emissions are likely to be dominant sources in site soil. The lead in the samples tested in the swine study reflected a mixture of anthropogenic sources of lead, rather than a single specific source.

3) Non-soil sources of lead will contribute to dust lead and blood lead. The identification of paint in the soil samples also indicates that lead sources in homes may be contributing to lead concentrations in soil around the homes and dust concentrations in the homes. Because blood lead levels of young children are more affected by lead in house dust than in soil (Succop et al. 1998), the IEUBK lead model results may not provide accurate risk management information for reducing children's blood lead levels. Specifically, the IEUBK model is very focused on soil as the main source affecting children's blood lead levels. The model, as it is used, does not quantify cleanup levels in non-soil sources of lead. The model also assumes a much stronger relation between soil and blood lead than is actually observed with empirical data. The model assumes a change in the mean blood

lead level of about 7 μg/dL for a 1000-ppm change in lead soil concentration, versus a change of about 2 μg/dL based on a combined analysis of many lead sites (Succop et al. 1998). The EPA model assumes that the soil lead concentration is the average concentration contacted by the child in the yard, while the 2 μg/dL value is based on the relation between blood lead and lead in perimeter soil (which receives more impact from leaded paint from the house). Thus, the reductions in blood lead levels that the model predicts will result from soil remediation likely will not occur, because other sources of lead, such as lead in paint, will continue to contribute to blood lead levels, regardless of soil remediation. Therefore, the model over predicts the benefits of soil remediation on blood lead levels. It is important to consider this limitation of the IEUBK model in determining appropriate remedial approaches for lead in soil.

I hope you find this information helpful. Please contact me if you have any questions.

References

Barltrop, D., and F. Meek. 1979. Effect of particle size on lead absorption from the gut. Arch. Environ. Health 34:280–285.

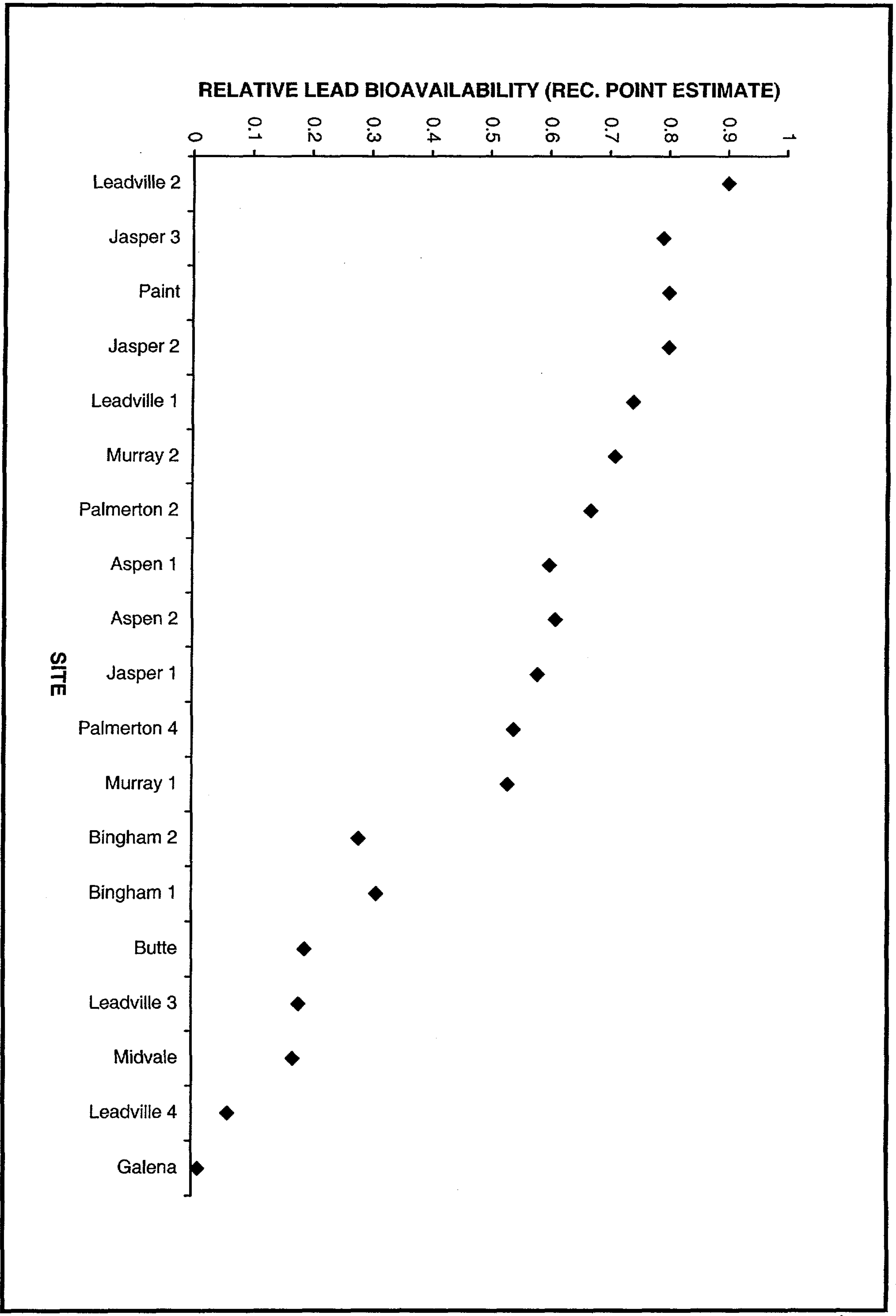
EnviroGroup. 1998. Evaluation of extent of impacts to soil due to air emissions from the Asarco Globe plant. EnviroGroup, Denver, CO. April 7.

Francek, M.A. 1992. Soil lead levels in a small town environment: A case study from Mt. Pleasant, Michigan. Environ. Pollut. 76:251—257.

Ruby, M.V., R. Schoof, W. Brattin, M. Goldage, G. Post, M. Harnois, D. Mosby, S. Casteel, W. Berti, M. Carpenter, D. Edwards, D. Cragin, and W. Chappell. 1999. Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. Environ. Sci. Technol. 33(21):3697–3705.

Succop, P., R. Bornschein, K. Brown, C.-Y. Tseng. 1998. An empirical comparison of lead exposure pathway models. Environmental Health Perspectives Vol. 106, Supplement 6, 1577-1582.

Weston. 1995. Draft dosing materials characterization report for the Phase II bioavailability study. Document Control no. 04800-030-0097. Prepared for U.S. Environmental Protection Agency, Region VIII, Denver, CO. Roy F. Weston, Lakewood, CO..



Relative lead bioavailibility in young swine.
(data from Ruby, et al., 1999)